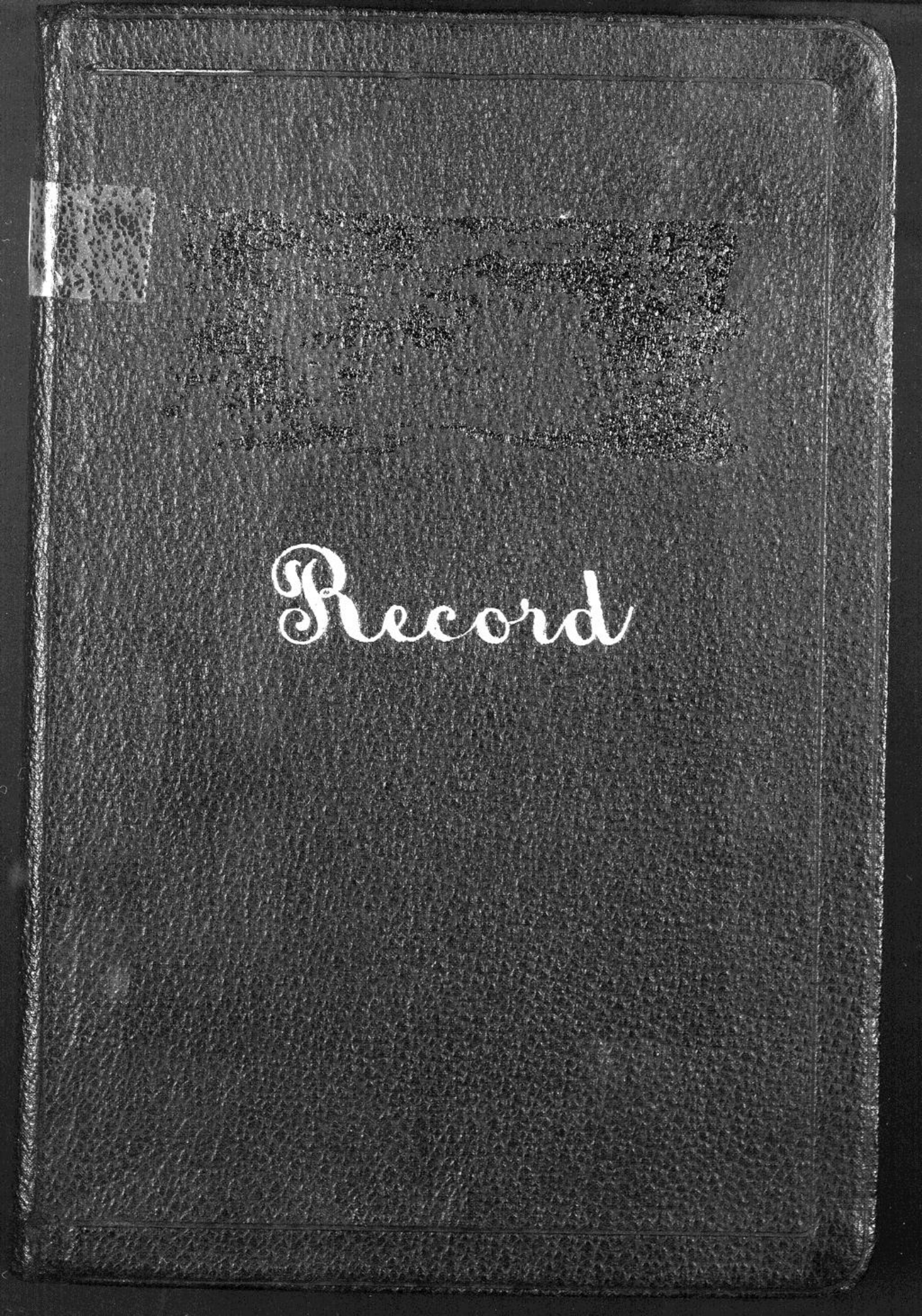

Record

The Result of some Experiments in connection with "Visible Speech" made in Elgin in November 1865

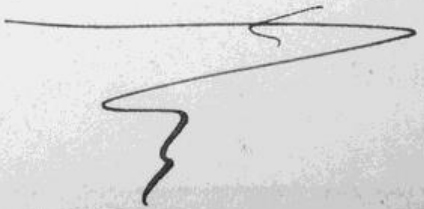
Home Notes

from June 18 1908
to

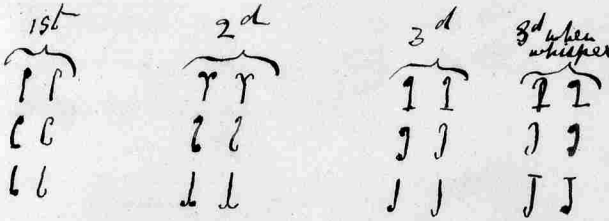
Property of Alex. Graham Bell

1331 Connecticut Avenue
Washington D. C. } Winter address

Beinn Bhreagh, near Baddeck,
Nova Scotia, Canada } Summer address



musical scales of vowels, subject to the ~~last result~~ same law; each scale commencing a little higher in pitch than the preceding. The scales seem to be



with the finger; if a catch is used, these scales ascend; if the A position, they descend.*

My explanation is as follows.

1st If you take a bottle and gradually fill it with water the sound ascends as the bottle gets fuller;† thus if you say the mouth is the bottle ~~and~~, the mouth being closed, A representing, as it were, the bottom of the bottle) then the tongue by filling up the

---

* Of course you cannot judge of the 3d scale in the A position; as you could scarcely have the tongue in both that and the back vowel position.

† which you can ascertain by blowing into the bottle from time to time.

cavity of the mouth, represents the water; thus where the cavity is smallest (I) the pitch of the sound will be highest, and, where the cavity is largest (I) the pitch will be lowest, agreeing perfectly with my experiment.

2.d Again — take a bottle, with a pretty wide mouth, and blow into it — a sound is produced — a husky kind of sound, not quite a whistle but approaching to it, and in which pitch is clearly audible.

Now if you take your hands and, (still blowing into the bottle) gradually close the opening, the pitch descends. Or if you whisper any of the primary vowels — narrow or wide, and gradually close the lips the pitch descends.

Well take the mouth to be

the bottle. The catch represents the bottom of the bottle, converting a tube, as it were, into a bottle. Then there is the cavity of the Pharynx, and the vowel positions become, so to speak, the mouth (or neck of bottle) of the bottle the closest opening (ɪ) producing the lowest pitch, and the most open position (ɹ) the highest.

Suppose the mouth in the most open position with the catch, then gradually close the lips, thus shutting the mouth of the bottle, and the pitch descends. Thus accounting for the statement in my last letter, that with the catch, the pitch ascended from ɪ to ɹ but descended again on closing the lips. This view also accounts

for all the seeming inconsistencies arrived at in the former experiments.

To make my meaning more apparent, I have attempted to give a drawing of some of the positions.

The shaded, or dark parts show the shape of the oral or Pharyngal cavity. The arrows in fig. 3, 4, and 5 point out the narrowed neck of the bottle. And as, the narrower the neck, the lower the pitch, these — closest of their classes — are also the lowest in pitch.

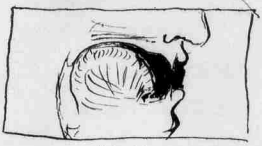
In trying the experiment I find it best, to put on the "X" Imagine myself pronouncing the vowel scale — (only however taking the vowel positions with a put emission of breath or inspiration) And then to tap my lower teeth with my thumb nail — in fact to "fillip" it.

G Position

fig. 1

"I" ~~for~~ "G" highest in pitch

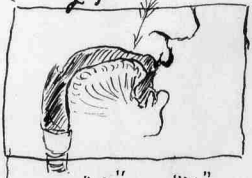
fig 2.



"l" lowest in pitch

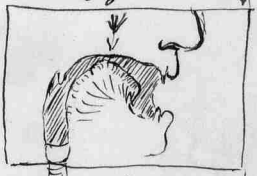
"X" Position

fig 3



"I" with "X" lowest in pitch of front class

fig 4

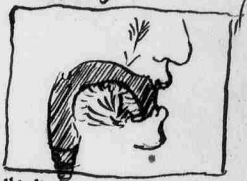


"Y" with "X" lowest in pitch of mid class

fig 5

"I" with "X" lowest in pitch of back class

fig 6



"l" with "X" highest of the front class.

The arrow shows the neck of the bottle

fig 7

"I" with "X"
highest in pitch
of mid class.

fig 8

"J" with "X"
highest in pitch
of back class

fig 9.

Ɔ or rather I-Ɔ with "X"
lowest in pitch of its
class —.

Points worthy of note—comparing Drome № 3 with Drome № 2.

№ 3 is heavier, has greater head-resistance, wing-surfaces more porous, & propeller broader on one side.

Greater weight & less efficient supporting surface. Most important object to my mind is the porosity of the material covering the wings. The new tent is of the Concavo-convex form ⌓.

The experiment were made this evening at 7.55 p.m. — when it was getting dark. about 100 spectators.

Further experiments tomorrow.

Plans: Mabel & I & Miss Cadell leave for Buffalo Tomorrow evening. Will stay at Iroquois Hotel — Leave ~~Buffalo~~ Brantford Monday afternoon 4.55 p.m. reaching Brantford, Ontario about 8 p.m. Remain Tuesday in Brantford. Leave Brantford Wed. for Toronto, Ten Thousand Isles, Montreal, Quebec, & Sydney, N.S.

Well — to commence again —
"If you take a pitchfork" and
sound it before the open mouth,
you hear it very softly: If
you make a X and move your
tongue through all the
positions of the vowel scale,
you will find one, in the
front scale (I make it out to be
ɛ with a C ~~tuning~~ pitch fork) which
makes the fork sound out loudly,
more like a harmonium note
than anything else —.

If while in that position
we hold the pitchfork in
front of the mouth and close
the lips a little, the note becomes
soft, but, (keeping the lips in the closer
position) on putting the tongue
into the "ɛ" position the note
becomes loud as before —
and why? — We see the reason
at once by the bottle theory:
the "ɛ" position, or neck of bottle

is more open than C and therefore (see 2d explanation page 3) is higher in pitch; but the lips, or mouth of the bottle, being closer than for l alone, (on the same principle) and therefore makes the note lower than l with no lip modification. Then the case stands thus: C = "C" and l raises the pitch above "C", but the lips lower the pitch again till the combination C of l, and lip modification, equals in pitch the "C". Then that combination is identical with C in pitch, differing only as regards quality. Just as a trumpet and a flute may sound a note which may be the same as regards pitch, but how different in quality!

Again l, with a further closing of the lips may be made identical in pitch with C. &c. &c. &c.

Now if we represent the various openings of the mouth by algebraical letters, or merely by numbers, or by fractions we may come to rather a curious result. I will try and explain what I mean by roughly giving an example.

Suppose we represent the position which gives the highest pitch, by the figure 1. and the next position on your scale, 2, (although there must be an infinity of positions between the two - just as, in mathematics, there must be an infinity of points, between any two points on a line, or as, in Time, there must be an infinity of Presents, (or rather points of time) between any two periods of Time) Then let us say, the highest in pitch in the front scale

~~[illegible]~~

or in other words ɩ = 1
the next in order ɩ = 2
— — — — . . ɩ = 3
— — — — — — — ɩ = 4
— — — — — ɩ = 5
— — — — — ɩ = 6

Let us also represent the lip openings. The highest in pitch will be represented by No. 0 as it cannot be said to affect the tongue vowels, the lips then in the unmodified position = 0
Lips in the position for ɟ = 1 *
— — — — — ɟ = 2
— — — — — ɟ = 3
— — — — — ɟ = 4
— — — — — ɟ = 5
— — — — — ɟ = 6

---

* These are as nearly as I can make out by the assistance of the instrument enclosed. I first marked off the positions for ɟɟɟɟ &c on the register, and on saying "ɩ" with No 1 closing of the instrument the fork was loud.

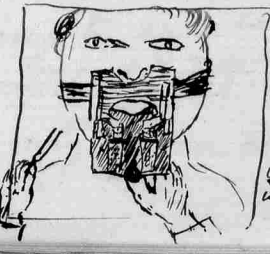
When C = "C" and C = 3 with lips in O

Then this result comes out

3 + 0° = C
2 + 1° = 3 and 3 = C
1 + 2° = 3 — 3 = C

On the register of my little instrument I have represented the openings with the signs for degree as in geographical degrees, to distinguish them from the lingual numbers.

Supposing I had a case of instruments — could I not come to some valuable result in this way. Open the mouth wide; apply my instrument, which should be tied on by a strip of something — move up or down the register with the left hand and hold



the pitch fork with the right hand before the orifice and look at yourself in a looking glass

If I had a box of instruments I might proceed thus. Pronounce some vowel, Let us suppose I, and find its pitch ~~[illegible]~~ suppose it to equal "A". Then take #G, and find the amount of modification necessary to change the "I" equaling "A", into a modified position equaling #G.

And proceed ~~[illegible]~~ with the same bingual vowel, till the mouth is closed. ~~Then invert~~

Number the openings, 1, 2, 3 &c.

Then invert the experiment. Take the "A" pitchfork with No. 1 opening of lips & find out what bingual vowel corresponds to it.

Then take the "#G" pitchfork with the 1 opening of the lips. And find out the vowel corresponding. Of course according to our supposition this would be "I"; but of course this is only taken as an example

for I have not made any experiment in this direction as yet, for, I have only a "C" pitchfork.

Find out the highest sound that can be made with the least opening of the lips, and number the lingual vowel "1"; take the next pitchfork below, with the same opening of lips, and the resulting vowel will be "2" and so on.

Dont you think that some valuable results might be obtained with pitchforks???

This may not be the proper modus operandi — but some other, might be hit on.

Another instrument might answer the purpose in experimenting just as well. ~~That instrument~~ I mean measuring

the opening of the lips with a pair of compasses. This form of the instrument would suit all mouths.

I suppose in a large mouth the lip openings for the vowels, would be really larger (though relatively the same), than in a small mouth.

If such a supposition is correct, then the other instrument (a rough model of which I send you) would not do; as it could not give the same result with all mouths.

~~Explanation of 2d instrument~~

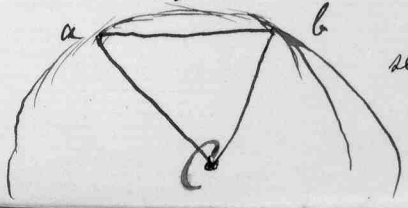
However large a circle is, we know it contains only 360 degrees; so if we measure the

lips by a definite part of a circle, however large the mouth may be, the relative openings will be represented by the same number of degrees minutes seconds &c. that [illegible] by a small one.

Let us take the widest position of the lips and make a straight line from side to side of the lips equal to "the chord of sixty degrees" that is — the line from side to side equals the radius of a circle from which it cuts off an segment. the line from side to side equals a b.

C the centre of circle.

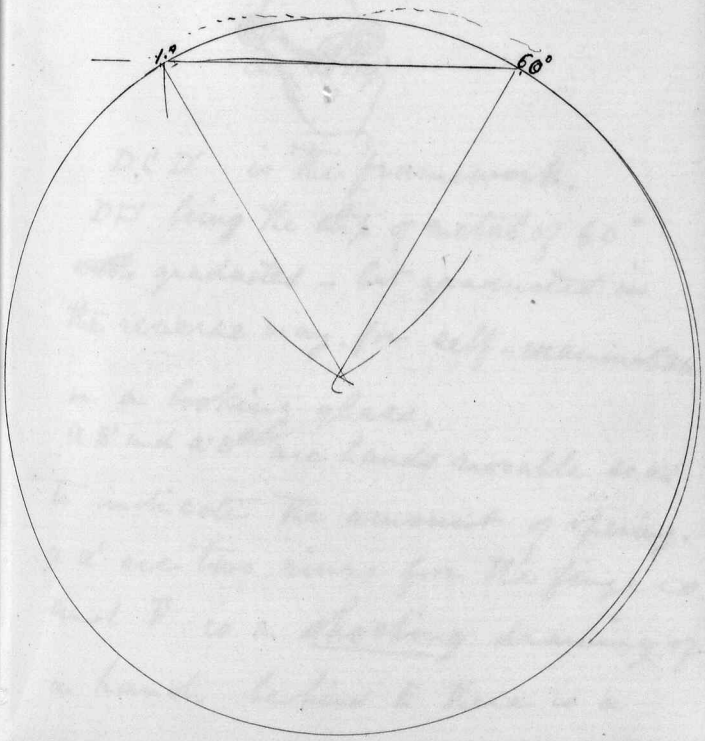
fig 10



see fig. 11

I would make the instrument in this way. Have a slip of metal about half an inch in breadth ~~[illegible]~~ sixty degrees of a circle. See fig 12. over page.

fig. 11



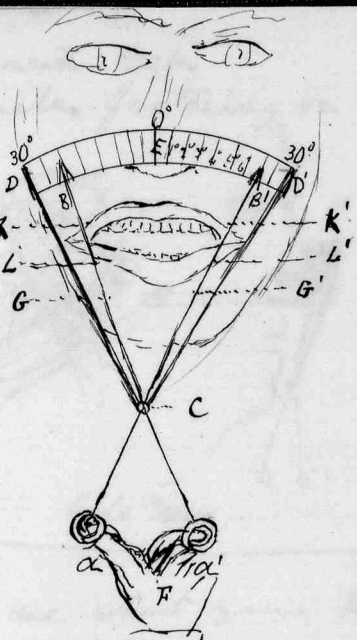


fig 12

D C D' is the framework.
D D' being the slip of metal of 60° ~~the~~ graduated – but graduated in the reverse way, for self-examination in a looking glass.
A B' and a' B ~~the~~ are hands movable so as to indicate the amount of opening.
α α' are two rings for the fingers.
and F is a shocking drawing of a hand. behind E there is a

or rather clasp
semicircle, fastening on to the nose

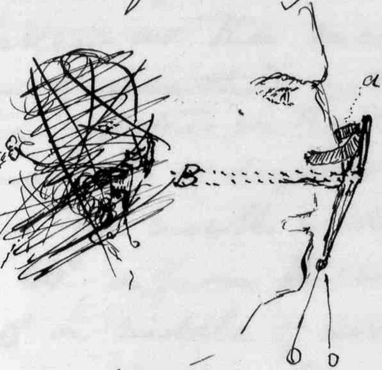


fig 13

Side view.

Tell me what you think of this !!!!!!!!!!!!!!!!!!!!!!!!!

To suit the different sizes of mouths the clasp (a fig. 13) is fastened further up, or further down on the nose. For a small mouth, pretty far up, and then ~~the~~ GG' in fig. 12 would come over the mouth. And although the real distance from G to G' is

less than from L to L' (taking the latter as the medium size of mouth) yet we find on the register on the top that the number of degrees are the same. The mouth wide open being 60° or from the central line 0° or middle of mouth 30° on each side. For a large mouth the clasp (A fig. 13) would be moved further down on the nose and K K' on fig 12 would be opposite the mouth. And although the distance from K to K' is greater than from L to L' the degrees are the same. and thus this instrument will suit every mouth. It might also be fastened on by a piece of tape round the head along the dotted line B (fig 13).

The application of the 2d instrument would be similar to that of the first only you would represent the bowels by degrees, minutes, seconds &c. instead of numbers. You would conduct an experiment somewhat after this fashion.

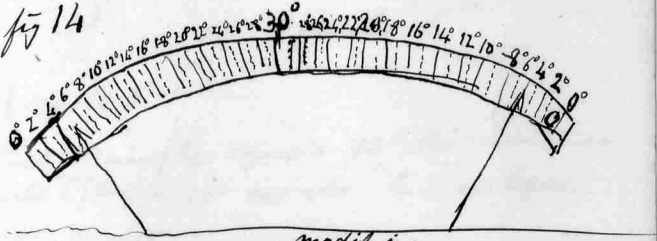
Fasten on the instrument, and seat yourself in front of a looking-glass. Take hold of the rings with the fingers and thumb of the left hand, so as to be able to close the scissor-like hands. (a B and a' b fig. 12) Hold the pitchfork in front of the mouth.

Suppose I sounds with the "d" pitchfork, then take the "#g" pitchfork close the lips till the sound is forte, then with

the left hand close the hands till each index is ~~open~~ opposite ~~each~~ the corresponding extremity of the opening of the lips. note the number of degrees on the register.

The mouth wide open would be 0° quite shut 30°

fig 14



The first or widest modifying opening of the lips might be about 5° perhaps. Then

"a" = I , "#9" = I +5° &c. &c.

This is supposition — given solely as an example.

Then let us always represent the ~~lig~~ largest in pitch by the lowest number. So first let us represent the widest in front scale as "I" 0° and the front scale completely closed "O" 30°

Then b (which seems by my experiment to equal C) would most likely be about 10° of the closing of front scale. Then taking that supposition, (correct or incorrect) as an example we have.

C equals "C"

C equals 10°; therefore ——

10° equals "C"

b equals 5°

5° with 5° opening of lips equals 10°; this combination equals "C"; therefore 10° equals "C" as before.

b equals 0°

0° with 10° opening of lips equals 10°; this combination equals "C"; therefore 10° equals "C". as before.

Do you not think there is something in this. ?????

If we try to get a stereoscopic view of the vowels, as it were, it seems to me, the vowel

scale stands out in a new light — By throwing together a few of the principal facts.

1st It has often struck me that, in whispering the vowels, there was a break, between U and Y; And you remember, (when I was whispering the scale to Mr. Ellis) when I got to Y, he said "Ah! there's a jump." and he said the same between Y and I; and between I and E.

2d I have often found that I could move my tongue backwards without altering the pitch at all; and in pronouncing a vowel (take for example U) I could without sensibly altering the sound, move the tongue backwards, till

the vowel became a consonant having the quality of the vowel in it; in fact, (using the vowel as an adjective) you might say— "it is [Visible Speech symbols] 'l' [Visible Speech symbols]" (an ă ch)

3d. In my last experiments with the "C" pitchfork, I have found that more than one of the primary vowels are in unison with it.— Thus [Visible Speech symbol], and [Visible Speech symbol] and [Visible Speech symbol] make the pitchfork "C" sound forte. With No. 1. opening of lips [Visible Speech symbol] and [Visible Speech symbol] (?)*1 and [Visible Speech symbol]; with No 2. [Visible Speech symbol], [Visible Speech symbol](?)*2 and [Visible Speech symbol]. With No 3 opening of the lips. none of front, [Visible Speech symbol], and [Visible Speech symbol]. With No. 4 opening of lips— front [Visible Speech symbol], mid [Visible Speech symbol], back [Visible Speech symbol].

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* I put the mark of Inquiry after this because I cannot be sure if we ~~have the same vowel~~ agree in the pronunciation. In "*1" I get the sound by attempting to say [Visible Speech symbol] with middle raised ~~and pitchfork sounds~~; in "*2" by saying [Visible Speech symbol] with mid.

4th. By making a scale of open-curve-symbols (ΩC) you have in the series from Ω to C the qualities of a vowel scale (this refers of course to whispering the sounds, not to the pitch fork or the finger) the first (Ω) agreeing with I; and the rest agreeing respectively to I, C, C, b, &c. &c.

5th. The vowel scales, from I to b in the front, ~~scale~~. from I to J in the mid, and from J to J in the back, ~~descend~~ ascend ※ because they form, as it were, the neck of a ~~bottle~~ bottle, or the termination of the bottle. If these scales are whispered they descend, because then the scales form as it were the commencement of a pipe. And we know, the

※ The best scale to test this, is the lip scale because it is above the mouth of the bottle. But in the other scales there is a cavity always enlarging in front of the scale. Where the cavity in front is least, the disturbance to the theory is least; so of the linguals the front scale is the least, and the back, the worst. In the lip scale there is no disturbance.

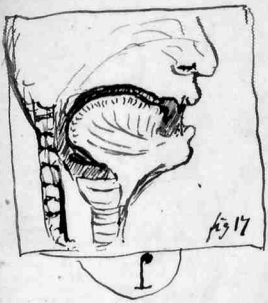


fig 17


fig 18

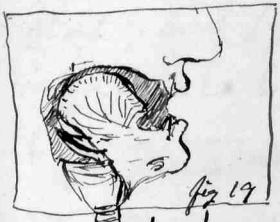


fig 19

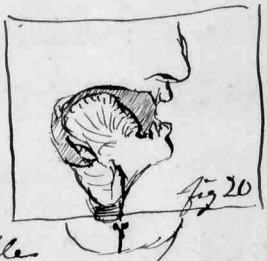


fig 20


Your Table
Proposed Table


fig 21

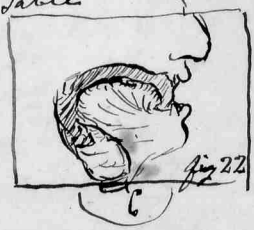


fig 22


fig 23


fig 24

Fig 21 is supposed to be the same as fig 17. ——

Fig 22 is evidently exaggerated and so is fig 23. Fig 22 would be about "l" and one between that, and fig 21, would be about right for C. ??????????

There are several other things in favour of the proposed theory. How is it we get the sounds of one scale — why by the help of another. Thus to get I ~~to try you to~~ to try and say I with the middle raised. That is —— the part where the aperture is to be made is at the middle, and the size of the opening is the same as for I. — To get I or rather ?, raise the middle, and say C. The degree

of opening the same as for C
and the aperture at the middle.
So you derive the backs from
the mids. With the high
back - narrow you say "try and
say ~~I~~ with the back of
or rather without the lips.
the tongue; and this would
also answer the purpose as
well - Make an attempt
to pronounce I ~~at~~ with the
back of the ~~front~~ tongue. Aperture
at back same number of degrees
of opening as ɪ, ɪ, or I.

Has it never struck you
in whispering the vowels,
how difficult it was
to decide which was the
higher of two vowels,
say ɒ and ɔ; although you

could feel a great difference yet you could scarcely feel certain which was the higher — at least I have found it so; and I can remember when we were doing it together. I thought ~~the d was~~ it lowest the J the lower, you thought the b — and the probability is — we were both right.

If we pronounce b and J with a rush of breath J is undoubtedly the highest — that is —, if the rush is caused by the contracted glottis, thus making the vowel position the termination of a pharyngal pipe, — the tongue being further forward for b than for J, the cavity behind

~~narrower it~~ narrower the pipe the higher the pitch. But in the case of the bottles the ~~narrower~~ narrower the pipe, (or neck of bottle) the lower the pitch. We see this, (the first statement) in various musical instruments.

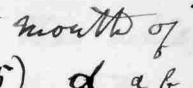
Thus a fife is narrower than a flute — and a treble-pipe of an organ, than a bass one.

Also in regard to the bottle theory

And how often have we not, in trying to play a tune on glass tumblers, poured in water till we heightened the pitch sufficiently, analogous to the scale with the tongue in the (e) position. Or again, in the picciola pipe — (I forget if that is the name, but it will do with any pipe) have we not found that, after stopping up the end of the pipe and also the holes, that we lower the pitch by gradually closing

the mouth of the whistle.

(fig 15)



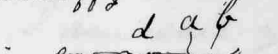
a b and C (in the piccola pipe) being stopped up; the cavity between d and C corresponds to the pharyngal cavity when, (with the vowel-scale) the catch is used; (compare page 6.) and the opening d corresponds to the different openings of the vowel position — if ~~that~~ the opening d, is gradually closed, the pitch is gradually lowered, and if the vowel aperture is gradually closed, the pitch is gradually lowered. Thus ~~d~~ l is lower than b, C than l &c.

Again fig 15 suppose d, a, and b, closed up, but C open. On blowing in at e, a hooky sound is produced, not a whistle, but pitch is discernible; thereby closing the opening C the pitch is gradually lowered, corresponding

to the whispered scale of vowels, the opening C being represented by the lips; and so although from the close position to the open in whispered lingual vowels, descends, yet, with the labial whispered vowels, the contrary is the case, namely — the scale from open to close descends. If the back of the tongue is formed into a pipe and the point of the tongue is so raised as to cause a cavity between the back and the point, (in whispering) the closer the point is to the palate — the lower will be the pitch. thus form at the back the pipe C and combine with that position, that of an Ŭ, the nearer the point is to the palate, the lower the pitch.

fig 16

repetition of fig 15.

Again 

a and b closed, Then C on being slowly closed, the pitch of the whistle is lowered — So in the vowel scale nasalized, and whispered; (the nasal passage corresponding to opening d fig 15.) on the lips being slowly closed, the pitch is lowered.

In the finger experiment (beating against the lower teeth with the thumb-nail, while having a cattle)

the scales from ♯ to ♭ from ♮ to ♯ and from ♯ to ♮ ascend, but, if the nasal passage is opened the scales, seem, (which I have only this moment tested) to descend. I will try this last experiment again, and also see what effect opening of the nasal passage has on the pitchfork.

I am sure you must be heartily tired before you reach this point, and I must condense what more I have to say, into as short a space as possible; although I can hardly expect you to read this through at one sitting. But I think it better to say as much as I can in one letter, and register it, than to refer to "Visible" at all in any of my common letters, as I am convinced there was some foul play with my first "Visible" letter, as I have never received the letter from you, that would have been the answer to it. I hope however it may turn out to be of no consequence.

By putting every-thing together I think we have hitherto had a partly false idea of the vowels.

It seems to me that the differences of vowel quality are principally if not wholly due to the size of the oral aperture. So taking the front scale, as a type of all the others, and setting aside the difference between the narrows and wides, for a short time, — what is the difference between [and ɛ.

Our old definition would be, the front of the tongue is more depressed for ɛ than for [in fact that [is a pipe one end of which is opened a little. This seems to me to be

a false explanation.

Of course no person can deny that the front of the tongue seems more depressed for ɔ than for ɔ, but is not the whole tongue depressed — Is not the position for ɔ identical with that of ɔ, only with the whole tongue further away from the palate — ??!?!!

If each of the front scale had the opening a little further back; and the high-mid-narrow just a little further back than ~~how~~ the low-front-wide how is it that there is such a palpable jump between the two, and also, in a musical way, a corresponding jump between the two. Musically speaking there is not so much difference between ɔ and ɪ as there is between ɪ and ɪ or ɔ and ɒ.

the ɔ will be larger than the cavity behind the ɹ and therefore the ɔ will be lower in pitch. But if the audibility of ɹ is caused by the contracted vowel position, then the vowel position becomes the commencement of a pipe, and as ɔ is further forward than ɹ the cavity in front of it is smaller than for ɹ and therefore the pitch higher.

I see it has struck you also that what we call the wides, in the back scale are higher in pitch than the narrows — yet with the finger experiment they

are lower in pitch; and ~~It not the~~ they are also lower if the breath is made audible by the glottis. Is not this the explanation:—

The tongue is further back [nearer the back of palate] ~~than~~ for ɪ than for ɪ making the cavity in front larger; and therefore the pitch lower for the narrow. But in the case of the closed or contracted glottis — the cavity behind ɪ is smaller than for ɪ (the tongue being further back) and therefore the pitch is higher. If I say all I wish to say — it will take another week (with my limited time) to finish my letter. Good Gr
week.